A PERFECT AMALGAM – THE COMBINATION OF COMPANY IN-HOUSE TRAINING WITH AN ACADEMIC ONLINE CERTIFICATE PROGRAM

Charlotta E. Sanders[*]
Department of Mechanical Engineering
University of Nevada Las Vegas (UNLV), Las Vegas, Nevada, USA
Charlotta.Sanders@unlv.edu

Quentin T. Newell
URENCO USA
PO Box 1789, Eunice, New Mexico, USA
Quentin.Newell@urenco.com

ABSTRACT

A well-trained and qualified workforce is an essential element in the modern day work place of the nuclear industry. For generations, from the guilds of the Middle Age through to the early Industrial Age, people learned their crafts through hands-on training provided at the hands of masters. Today, though there is an ever-pressing need for mentoring in the workplace, the fast-paced environment and lack of time to develop specific in-house training programs can create hindrances to both formal and informal learning in the work place.

One way to overcome this gap is through private company and academic collaboration. In 2012, the University of Nevada, Las Vegas (UNLV) developed a Nuclear Regulatory Commission sponsored Nuclear Criticality Safety Certificate Program. In collaboration with URENCO USA, an online version of the program was also developed to assist the URENCO criticality workforce in the nuclear criticality safety (NCS) qualification process to further their education.

This paper looks into the differences between formal and informal learning and how factors, which shape informal learning, are used to compliment formal learning in the work environment. It further discusses how a collaborative relationship between private and academic partners can assist a company in maintaining a high level of expertise, while assisting with a company's goals of fostering, sustaining and strengthening the nuclear safety culture.

Key Words: **Informal Learning, Professional Development, Nuclear Safety Culture.**

---

[*] www.unlv.edu/me

1. INTRODUCTION

“*Learning without thought is labor lost; thought without learning is perilous*.” Confucius

Black’s Law Dictionary defines ‘learning’ as “the act of acquiring knowledge” [1]. According to Aristotle, “The educated differ from the uneducated as much as the living from the dead” [2]. More than two thousand years ago, Aristotle perceptively highlights a central conundrum of the modern-day nuclear workplace. This is that a well-trained and qualified workforce (especially in the area of nuclear criticality safety (NCS)) is an essential element required to keep nuclear as a viable energy source.

The International Atomic Energy Agency (IAEA) noted in 2004 that the “safe, reliable, and cost-effective operation of [Nuclear Power Plants] requires that personnel possess and maintain the requisite knowledge, skills, and attitudes to do their jobs properly. Such knowledge includes not only the technical competencies required by the nature of the technology and particular engineering designs, but also the “softer” competencies associated with effective management, communication and teamwork” [3]. Providing a well-qualified and diverse workforce in the nuclear sector, for the 21st Century, is of vital importance in securing America’s economic future.

This paper looks into the differences between formal and informal learning and how factors, which shape informal learning, are used to compliment formal learning in the work environment. It further discusses how a collaborative relationship between private and academic partners can assist a company in maintaining a high level of expertise, while assisting with a company’s goals of fostering, sustaining and strengthening the nuclear safety culture.

2. INFORMAL vs. FORMAL LEARNING

Society has altered greatly in technology and knowledge over the past 300 years, as it has progressed through various educational and cultural periods (such as the ‘Age of Enlightenment’ of the 1700’s and the Industrial Revolution of the 1800’s). Even so, the fundamental methods of learning have not really been greatly altered. Learning can be said to comprise of one of two categories, formal or informal learning.

In most companies/organizations, such a formal learning structure is not usually the case. Generally, time does not permit that a new-hire employee has the benefit of formal instruction. Most training that is provided is that of self-study, in which the employee is expected to read a mountain of material without the opportunity to further discuss what the employee has, or has not, understood. Hence, the employee may gain feelings of inadequacies in the work setting, which are not prevalent to the employee’s actual abilities. Research has emerged which indicates that “the ways people actually work usually differ fundamentally from the ways organizations describe that work in manuals, training programs, organizational charts, and job descriptions” [4].

Further study shows that even students with considerable aptitude who view their cognitive abilities as fixed or unchangeable are more likely to experience greater discouragement, lower performance, and, ultimately, reduce their effort when they encounter difficulties or setbacks [5]. Thus, where it is possible to have an engaged mentor in the workplace setting, the chances for any employee to succeed greatly improves.

2.1. Mentoring in the Work Place

Informal learning in the workplace is not a new concept. In the Middle Ages, apprentices learned their craft at the feet of masters, while during the Industrial Revolution of the 1800's, shop workers were advised to "go sit by Nellie" in order that the worker might observe how the work is to be undertaken. The various professions of the time, originally fewer in number than today, built specialized, credentialed bodies of knowledge that was passed on through both pre-service and in-service education, liberally interspersed with socialization [6].

Beginning with the dawn of the Industrial era, in which a greater demand is placed for college certification in the fields of science and expertise, reason and objectivity gave rise to systematic approaches used to flush out and thereby transmit the "right" or "best" or most "efficient" way to work [6]. However, today's post-modern world, by contrast, is skeptical of the "one best way." According to Feibleman, "there is nothing cheaper or more prevalent than the absolute truth. Everybody has one" [7].

Solving a problem involves one or more cycles of trial and error in which learning takes place as one seeks to achieve a desired outcome. Through observing 'that which occurs,' this leads to course corrections and eventually to conclusions and planning for how one will address similar situations going forward [6]. However, in the fast-paced work environment, with its emphasis on production (e.g., producing results), time is not always allotted for mentoring sessions, to learn through trial and error, and/or participation in professional development activities.

In 1977, the government of the United Kingdom, in response to complaints from industry about a shortage of qualified engineers, invited Sir Harold Montague Finniston to set up a committee of enquiry into the status of British engineering. In 1979, the committee delivered the "Finniston Report," which addressed various concerns that the committee had noted. The Finniston Committee found that there is a need for continuing learning, or 'continuing formation,' in which it noted:

> "The main impetus for raising current levels of post-experience formation activities must come from individual engineers and their employers. Good employers will regard engineers as appreciating company assets and actively encourage them to involve themselves in such activities, both to their personal development and also to maintain the company's corporate expertise. **Engineers should demand time and financial support to participate in programmes which will benefit their company as well as themselves**." [8]

3. FACTORS THAT AFFECT INFORMAL LEARNING

A large part of the learning that takes place in the work place is through incidental, or informal learning processes. It is important to understand the various factors that have an effect on informal learning. These areas comprise: (1) the role of relationships, (2) culture, (3) structure, (4) leadership, and (5) the environment in shaping learning. A suggested general framework for creating an informal learning program is as follows [6]:

1. Given the difference between formal and informal learning, it is important that the employer clearly communicate the learning method to be used during a specific task in the workplace. Informal learning is that which “lacks systematic support explicitly organized to foster teacher learning” and emphasizes the “intrinsic and mutual relationship between working and learning.” [6] In the formal learning setting, however, both the “teacher” and the “student” work together to understand the outcome of the learning task. Studies confirm that informal and formal learning interacts in important ways, and each are valid in their domain within the workplace.

2. Informal learning can be studied by examining learning activities and processes, for example, experimenting, reflection (meaning- vs action-oriented), examining one’s own practice, getting and using ideas from others, learning by doing, learning from mistakes, mentoring, coaching, giving and receiving feedback, or conversations with colleagues.

3. Informal learning is difficult to link directly to outcomes but some links can be identified and assessed. For example, the way that a certain belief may affect choices and their consequences for an action taken. Though not every work task is defined as “learning” or “teaching” moments, it is important to comprehend that each action undertaken during the workday is essentially a “learning” experience.

4. Individuals bring themselves to their learning tasks, and so, their strategies and approaches are mediated by their beliefs, values, histories, and prior socialization. Studies support that an individual’s intentionality, proactivity, and critical thought affect the nature of their learning.

5. Context greatly affects learning practices and choices, including triggers for learning, resources, and environmental influences. One area of context that greatly differs between people is the use of language. Given how flexible language is, it should not be assumed that “synonymous meanings exist [for a descriptive word being used, such as ‘slightly’ or ‘conservative’], particularly if one is dealing with technical legal concepts” [9]. Therefore, “no matter how precise the language, the inherent imprecision of language usually raises questions of legitimacy in the applicability to a particular situation” [10].

6. Relationships (and facilitators or barriers to engaging in relationships) are key to building informal learning communities. It is the interaction between people in the workplace that facilitate how work is accomplished, and how an organization’s goals are achieved. To quote Stephen Covey, “Trust is the glue of life. It’s the most essential ingredient in effective communication. It’s the foundational principle that holds all relationships” [2].

7. Organizational factors (leadership, structure, culture, systems and practices, incentives and rewards) influence climate for learning and may be easier to “manipulate” when stimulating informal learning that are individual-dependent variables, or even the learning activity itself. The values “pushed” by the leadership structure within an organization, determine the sincerity of the employee in committing to these values of learning, as well as the greater ability to develop a firm commitment to the work/safety philosophy within the organization.

4. HINDRANCES TO INFORMAL LEARNING IN THE WORKPLACE

Both the National Society of Professional Engineers (NSPE) and the American Nuclear Society (ANS) recognize that engineering has a “direct and vital impact on the quality of life for all people” [11, 12]. It is essential that an engineer (especially a professional licensed engineer) only perform those services he or she is qualified by training or experience to perform. Therefore, continuous professional development through formal and informal learning situations in the workplace is vital in assisting an engineer in maintaining an ethical commitment to providing the highest standard possible.

Just as both partners in the workplace (i.e., the employer and employee) have a desire and need to access the possibility for professional development opportunities, each have a set of unique and shared hindrances that influence learning in the workplace.

4.1. Employee Unique Hindrances to Learning

Barrier 1 – Conflicts with Work Schedules

Employees usually have a heavy workload, and must meet certain targets in their work schedule. This requires that learning experiences should not cause an employee to fall behind with their normal work priorities. This may cause extra stress to the employee in worrying that their in-office work will suffer should they spend more time developing a new set of skills. The employer can assist in this area by setting schedules that allow for personal development time.

Barrier 2 – Conflicts with Family Responsibilities

Rushing from piano recitals to little league, etc., parents have much on their plate that they must attend to outside of the workplace. Many employees already struggle to find a balance of work and family, before adding in professional development into the mix. Professional development activities that occur at some distance from the home location, which require extended travel for a week or more, only add to the burden and guilt that can be felt by parents in spending extra time away from the family. When possible, the employee should be involved with the employer in participating in the selection of the professional development experience and schedule.

4.2. Employer Unique Hindrances to Learning

Barrier 1 – Time Needed to Develop In-house System of Learning

Not only do employees have heavy workloads, but also those in management positions have pressures in meeting targets in the work schedule. When it comes to the resource of time, it can be scarce. Therefore, the task to create the learning environment or to develop an in-house system of learning can take a back seat to other higher priority matters. Drew Hansen commented, “leaders who aren't disciplined in their priorities will be subject to daily crises that interfere with activities that are part of a long-term investment in people” [13].

Barrier 2 – Lack of In-house Resources

Certain subject matters are quite complex and require specialized knowledge. As such, it may be difficult to retain talent in-house to develop a particular comprehensive learning module. Bringing people in-house does have some advantages, but requires in-house people to stay current with developments in the industry. Furthermore, bringing in-house a dedicated employee generally requires full time work and benefits, when the position required may actually be an extended temporary or part-time situation.

4.3. Shared Employer/Employee Hindrances to Learning

Barrier 1 – Limited Inner-Company Opportunities for Advancement/Cross Training

One key barrier that exists within the work place for both the employer and the employee, which can provide a hindrance to learning, is the nature of the organization structure. Effective companies generally tend to have “a system or organization in which people or groups are ranked one above the other according to status or authority” [14]. This structure allows for clear division of responsibilities and workflow methods, but this system can also impede learning in the work place. The situation can often lead to engineers being pigeonholed into a certain role or expertise within the company structure. Thus, the IAEA recommends five areas of involvement of learning for young professionals in the work place. These five categories [3] are:

1. Working teams should include a mix of experienced and young employees, and a mix of expertise in order permit sharing of knowledge. The purpose is to develop flexibility in work organization.

2. Pre-job briefings are required for all but the simplest and most routine tasks. As discussed previously regarding the ‘language of uncertainty,’ this is an effective way to ensure that communication is clearly given, while allowing for a simple way to provide learning instruction in the work environment.

3. Young professionals are to participate as full members in working groups, meetings, conferences, reviews, and safety committees. They bring energy, fresh ideas and a questioning attitude to the job. This allows the young professional to see the full canvas and understand the fuller picture of the company/organization.

4. Proxies (substitutes) are defined for all functions. These proxies are expected to fully replace the persons they represent during any absences.

5. Job rotation is used as an important means for transferring knowledge. For example, maintenance personnel, who did a certain job during an outage, will be assigned a different job for the next outage, so they are qualified in a number of areas.

5. THE COLLABORATIVE EFFORT

Having discussed hindrances and barriers to learning in the work place, this paper now turns to one way for an organization to overcome these difficulties. One unique challenge for a U.S. Nuclear Regulatory Commission (NRC) licensed facility is to “promote and maintain the core values and behaviors resulting from a collective commitment by leaders and individuals to emphasize safety over competing goals to ensure protection of people and the environment” [15].

One method to overcoming these barriers is through collaboration with an outside organization. For URENCO USA (UUSA), it found cohesion of its in-house professional development goals, employee qualification requirements, and commitment to strengthening its nuclear safety culture commitment to foster continuous learning[†] by its participation with the University of Nevada, Las Vegas (UNLV) Nuclear Criticality Safety Engineering Certificate Program (NCSE) [16]. The certificate program was developed through a NRC grant to "provide the practicing NCS engineer (and their employer) with components that will help train and maintain a well-qualified workforce" [17]. The program was soon expanded, with a consideration of NCS staff training needs at UUSA, into the graduate, distance education NCSE certificate program.

The UNLV online graduate NCSE Certificate provides graduate students and the practicing NCS engineer an informal, yet "hands-on" instruction (i.e., hybrid), learning environment. The NCSE Certificate program consists of four nuclear engineering courses (twelve credit hours) that include three required courses and an approved elective course. The required courses are as follows:

1. ME 754 - Introduction to Nuclear Criticality Safety (3 credits)

The introductory course offers an overview of the physics of criticality, the factors that affect reactivity, review of criticality accidents, a look at standards and regulations, hand calculation techniques, engineering and evaluations for criticality safe processes in facilities, etc.

2. ME 755 - Nuclear Criticality Safety Engineering (3 credits)

The course builds upon ME 754 and offers a more in-depth look at the physics of criticality as well as practical engineering case studies, such as preparation of Monte Carlo based nuclear criticality safety evaluations, experimental development of subcritical limits, etc.

3. ME 756 - Monte Carlo Methods in Nuclear Engineering (3 credits)

The course covers the theory and application of the Monte Carlo method for neutron transport calculations from introductory concepts to advanced simulations of criticality in fissile materials. Other topics discussed include code verification and validation (V&V), review of nuclear data files, examples of Monte Carlo calculations, case studies, and applied problems.

4. Elective Course (3 credits)

Examples of approved electives include ME 795 Probabilistic Risk Assessment, which also includes Integrated Safety Analysis important to 10 CFR70 facilities and ME 791 Independent Study. The latter consists of advanced criticality safety or transport related topics of the student's choice approved by the instructor.

5.1. Benefits to UUSA and Employees

UUSA and its NCS engineers received multiple benefits through participating in the NCSE Certificate. For

---

[†] The NRC lists nine traits as part of a positive safety culture, where the trait **Continuous Learning** is "opportunities to learn about ways to ensure safety are sought out and implemented." [15]

UUSA as an organization, the NCSE Certificate program assisted with helping it to maintain a high level of in-house expertise and strengthen organizational learning components and practices. It had access to a NRC sponsored program, which it did not have to develop at its own expense. Furthermore, being an online certificate program, UUSA employees were able to participate from their home location, thereby not requiring travel away from the office and causing unnecessary extra-incurred expenses to the company. Finally, the NCSE Certificate program assisted UUSA in meeting company goals in fostering, sustaining and strengthening its nuclear safety culture through continuous learning efforts.

For employees at UUSA, participating in the online NCSE Certificate allowed for participation without much conflict to the work schedule. Most importantly, employees increased their knowledge and understanding of criticality safety. UUSA reimbursed the cost of tuition and fostered the learning environment by allowing a few hours each week in the work schedule for class work and personal study. Employees were able to minimize conflicts with family responsibilities in having the flexibility to self-determine their study schedule each week during the semester. Lastly, the employees had benefits of mentoring, not only through answer/question sessions with the instructor, but also through discussion boards with fellow students.

6. CONCLUSIONS

As the nuclear workforce continues to age, and more young professionals enter the nuclear workplace, a central challenge for any organization is to maintain a high level of expertise and training, while fostering informal learning in the workplace given work pressures on both the employer and employee. However, though there are challenges and hindrances to informal learning in the workplace, these can certainly be minimized through cost-effective means by private/academic collaboration in creating an informal hybrid system of learning. As online tools continue to develop, continuous learning opportunities will be more accessible to both the employer and employee. Thus, the knowledge gap between older/younger employees can be reduced, allowing for a more harmonious and safety conscious work environment.

ACKNOWLEDGMENTS

The authors would like to thank UUSA in supporting the effort and time to write the paper. In addition, the authors are grateful to Mr. Mark Callis Sanders, Managing Member of Nuclear Fuel Analysis Services, L.L.C. for his insights and literature recommendations.

REFERENCES

[1] Black’s Law Dictionary, Eighth Edition, St. Paul, MN, USA (2007).

[2] https://www.brainyquote.com/ (2017).

[3] “The nuclear power industry’s ageing workforce: Transfer of knowledge to the next generation,” IAEA, Vienna, IAEA-TECDOC-1399, ISBN 92-0-107704-1, ISSN 1011-4289 (2004), http://www-pub.iaea.org/MTCD/Publications/PDF/te_1399_web.pdf

[4] D. A. Jopp, “Formal and Information Collective Learning Systems: Understanding the Emergent Flow of Knowledge,” A Dissertation submitted to the Faculty of the Graduate School of Education and Human Development of the George Washington University in partial satisfaction of the requirements for the degree of Doctor of Education, January 30, 2006.

[5] C.S Dweck, “Is math a gift? Beliefs that put females at risk.” In S.J. Ceci and W. Williams (eds.), Why

aren't more women in science? Top researchers debate the evidence Washington, D.C.: American Psychological Association (2006).

[6] V. J. Marsick, "Toward a unifying framework to support learning theory, research, and practice" *Journal of Workplace Learning*, Vol. 21 No. 4, pp. 265-275 (2009).

[7] J. Feibleman, "Justice, Law, and Culture," Dordrecht: Matinus Nijhoff, pg. 3, (1985).

[8] S. Galloway, "The Professional Body and Continuing Professional Development: New Directions in Engineering" *Innovations in Education & Training International*, Sep98, Vol. 35 Issue 3, p231 (quoting from the Committee of Inquiry into the Engineering Profession, 1980, pp 118-19).

[9] J. A. Holland., J.S. Webb, *Learning Legal Rules, A Student's Guide to Legal Method and Reasoning, 4th Edition*, Blackstone Press Limited, Shrewsbury, England, (1999).

[10] M.C. Sanders and C.E. Sanders, "The Path Towards a Legitimate Radioactive Waste Management Program: A Comparative Analysis of the Legislative and Regulatory Approach to the Management of Radioactive Waste in the U.S.A. and China ", *Proceedings of the International Nuclear Law Association XXII Nuclear Inter Jura Congress* (R Rajesh Babu, M P Ram Mohan & Els Reynaers Kini), New Delhi, India, November 7-11, 2016.

[11] https://www.nspe.org/sites/default/files/resources/pdfs/Ethics/CodeofEthics/Code-2007-July.pdf (2017).

[12] http://www.ans.org/about/coe/ (2017)

[13] https://www.forbes.com/sites/drewhansen/2011/12/02/5-keys-developing-talent-in-your-organization/#e66645429a86 (2017).

[14] www.google.com search "hierarchy" (2017)

[15] https://www.nrc.gov/about-nrc/safety-culture/sc-policy-statement.html (2017)

[16] https://www.unlv.edu/certificate/grad-nuclear-criticality-safety (2017)

[17] US Nuclear Regulatory Grant No: NRC-HQ-12-G-38-0060 (2012) https://www.nrc.gov/docs/ML1225/ML12257A294.pdf (2017)